

CLAIMS

1. A fuel cell that generates electric power through reaction of a fuel gas with an oxidizing gas, said fuel cell
5 comprising:

an electrode assembly that has an electrolyte interposed between a pair of electrodes;

a pair of separators that are arranged across the electrode assembly, where one of the separators facing one of
10 the electrodes has an oxidizing gas conduit, while the other of the separators facing the other of the electrodes has a fuel gas conduit;

a sealing member that is formed along periphery of the electrode assembly in a gap between the pair of separators; and

15 a breaking guide that is used for breakage of at least one of the separators.

2. A fuel cell in accordance with claim 1, wherein the electrolyte is a solid electrolyte.

3. A fuel cell in accordance with claim 1, wherein the
20 breaking guide is used to break at least one of the separators at a position outside the electrodes but inside the sealing member.

4. A fuel cell in accordance with claim 1, wherein the breaking guide is formed at or in a neighborhood of a position
25 of the sealing member on at least one of the separators.

5. A fuel cell in accordance with claim 1, wherein the

breaking guide is formed in a thin-wall section formed on at least one of the separators.

6. A fuel cell in accordance with claim 1, wherein the breaking guide is provided on at least one of the separators
5 and is formed on a specific plane of the separator other than a plane facing the electrode assembly.

7. A fuel cell in accordance with claim 1, wherein the breaking guide is provided on at least one of the separators and is formed on a specific plane of the separator opposite to
10 a plane facing the electrode assembly.

8. A fuel cell in accordance with claim 1, wherein the breaking guide includes a recess continuously formed around periphery of the separator.

9. A fuel cell in accordance with claim 1, wherein the
15 breaking guide includes multiple recesses intermittently arranged around periphery of the separator.

10. A fuel cell in accordance with claim 9, wherein each of the multiple recesses has a polygonal opening which has at least one vertex angle of less than 90 degrees.

20 11. A fuel cell in accordance with claim 8, wherein the recess has any of a wedge-like cross section, a quasi-V-shaped cross section, a quasi-U-shaped cross section, and a quasi-circular cross section in depth of the separator.

12. A fuel cell in accordance with claim 9, wherein the
25 recess has any of a wedge-like cross section, a quasi-V-shaped cross section, a quasi-U-shaped cross section, and a

quasi-circular cross section in depth of the separator.

13. A fuel cell in accordance with claim 8, wherein the recess is also used as a coolant conduit disposed in the separator.

5 14. A fuel cell in accordance with claim 1, wherein the breaking guide is provided on at least one of the separators and is mainly made of a different material having a different physical or chemical property from a physical or chemical property of a material of the separator.

10 15. A fuel cell in accordance with claim 14, wherein the breaking guide is formed in the separators to make surface of the separator substantially flat and even.

15 16. A fuel cell in accordance with claim 14, wherein the breaking guide is formed continuously formed around periphery of the separator.

17. A fuel cell in accordance with claim 14, wherein the breaking guide is formed intermittently arranged around periphery of the separator.

20 18. A fuel cell in accordance with claim 17, wherein the breaking guide has a polygonal exposure area with at least one vertex angle of less than 90 degrees, on surface of the separator.

25 19. A fuel cell in accordance with claim 14, wherein the breaking guide has a wedge-like cross section in depth of the separator.

20. A fuel cell in accordance with claim 14, wherein the

different material has a practically equivalent electrical conductivity to an electrical conductivity of the separator.

21. A fuel cell in accordance with claim 14, wherein the different material has a different hardness from a hardness of
5 the separator.

22. A fuel cell in accordance with claim 21, wherein the different material has a higher hardness than the hardness of the separator.

23. A fuel cell in accordance with claim 21, wherein the
10 different material has a lower hardness than the hardness of the separator.

24. A fuel cell in accordance with claim 1, wherein the breaking guide comprises a blockage member that is formed on or outside the periphery of the electrode assembly in the gap
15 between the pair of separators to prevent the gap from being narrowed less than a preset width under application of a pressing force in a direction of narrowing the gap.

25. A fuel cell in accordance with claim 24, wherein the blockage member is arranged along periphery of the separator
20 not to interfere with smooth supply and discharge of the fuel gas and the oxidizing gas.

26. A fuel cell in accordance with claim 24, wherein the blockage member is made of a dielectric material.

27. A fuel cell in accordance with claim 24, wherein top
25 and bottom portions of the blockage member come into close contact with the pair of separators to prevent leakage of the

sealing member, when the blockage member is pressed toward an end of the separator.

28. A fuel cell in accordance with claim 24, wherein the blockage member has a quasi-circular cross section in depth of
5 the separator, and each of the separators has a gradual-varying portion to gradually narrow the gap between the pair of separators toward ends of the separators.

29. A fuel cell in accordance with claim 28, wherein the blockage member includes either round bar members or spherical
10 members arranged along periphery of the separator.

30. A fuel cell in accordance with claim 1, wherein the breaking guide includes an inclined face that is formed on at least one of the separators and is extended from an outer end position of the sealing member or its nearby position toward
15 an end of the separator to gradually widen the gap between the pair of separators.

31. A fuel cell in accordance with claim 30, wherein the inclined face keeps a space for inserting a cracking tool having a sloped edge into the gap between the pair of separators.

20 32. A fuel cell in accordance with claim 31, wherein the inclined face has an angle of inclination that is not less than an angle of gradient of the sloped edge of the cracking tool.

33. A fuel cell in accordance with claim 30, wherein the breaking guide includes the inclined face and a horizontal face
25 that is formed on the other of the separators to guide a horizontal movement of an edge of a cracking tool inserted

inward into the gap between the pair of separators.

34. A fuel cell in accordance with claim 1, wherein the breaking guide includes a thin-wall section formed on at least one of the separators.

5 35. A fuel cell in accordance with claim 34, wherein the thin-wall section is formed by cutting down a plane of the separator facing the electrode assembly.

36. A disassembly method of disassembling a fuel cell, which comprises: an electrode assembly that has an electrolyte
10 interposed between a pair of electrodes; a pair of separators that are arranged across the electrode assembly, where one of the separators facing one of the electrodes has an oxidizing gas conduit, while the other of the separators facing the other of the electrodes has a fuel gas conduit; and a sealing member
15 that is formed along periphery of the electrode assembly in a gap between the pair of separators,

said disassembly method comprising the step of:

applying an external force from outside of said fuel cell to an outer face of at least one of the separators or the gap
20 between the pair of separators, so as to facilitate disassembly of said fuel cell.

37. A disassembly method in accordance with claim 36, wherein said disassembly-facilitating step applies the external force to a position outside the electrodes but inside
25 the sealing member on at least one of the separators.

38. A disassembly method of disassembling a fuel cell,

which comprises: an electrode assembly that has an electrolyte interposed between a pair of electrodes; a pair of separators that are arranged across the electrode assembly, where one of the separators facing one of the electrodes has an oxidizing
5 gas conduit, while the other of the separators facing the other of the electrodes has a fuel gas conduit; a sealing member that is formed along periphery of the electrode assembly in a gap between the pair of separators; and a breaking guide that is used for breakage of at least one of the separators,

10 said disassembly method comprising the step of:

utilizing the breaking guide to apply an external force from outside of said fuel cell to an outer face of at least one of the separators or the gap between the pair of separators, so as to facilitate disassembly of said fuel cell.

15 39. A disassembly method in accordance with claim 38, wherein said disassembly-facilitating step applies the external force to a position outside the electrodes but inside the sealing member on at least one of the separators.

20 40. A disassembly method in accordance with claim 38, wherein the breaking guide comprises either one recess formed continuously along periphery of the separator or multiple recesses formed intermittently along the periphery of the separator, and

25 said disassembly-facilitating step uses a cracking tool to apply the external force to the breaking guide and thereby break at least one of the separators.

41. A disassembly method in accordance with claim 40,
wherein said disassembly-facilitating step places an edge of
the cracking tool on a bottom of the recess and applies the
external force to the bottom, so as to break at least one of
5 the separators.

42. A disassembly method in accordance with claim 40,
wherein said disassembly-facilitating step sets a bottom of the
recess where an edge of the cracking tool is placed, as a point
of application, an opening edge of the recess where a flat side
10 of the cracking tool is placed, as a point of support, and a
base end of the cracking tool where a force is applied, as a
point of power, and applies the external force to the point of
application by principle of leverage, so as to break at least
one of the separators.

15 43. A disassembly method in accordance with claim 40,
wherein said disassembly-facilitating step provides the
cracking tool having a sloped edge and inserts the sloped edge
of the cracking tool into an opening of the recess to apply the
external force in an expanding direction to the recess, so as
20 to break at least one of the separators.

44. A disassembly method in accordance with claim 38,
wherein the breaking guide is provided on at least one of the
separators and is mainly made of a different material having
a different physical or chemical property from a physical or
25 chemical property of a material of the separator.

45. A disassembly method in accordance with claim 44,

wherein said disassembly-facilitating step uses a cracking tool to apply the external force to the breaking guide and thereby break at least one of the separators.

46. A disassembly method in accordance with claim 44,
5 wherein the different material is a material of a higher hardness than a hardness of the separator, and

said disassembly-facilitating step uses a cracking tool to apply the external force to the breaking guide and thereby press the breaking guide into depth of the separator for
10 breakage of the separator.

47. A disassembly method in accordance with claim 44, wherein the different material is a material of a lower hardness than a hardness of the separator, and

said disassembly-facilitating step places an edge of a
15 cracking tool on the breaking guide and applies the external force to the breaking guide to press the edge of the cracking tool into depth of the separator and destroy the breaking guide for breakage of the separator.

48. A disassembly method in accordance with claim 38,
20 wherein the breaking guide comprises a blockage member that is formed on or outside the periphery of the electrode assembly in the gap between the pair of separators to prevent the gap from being narrowed less than a preset width under application of a pressing force in a direction of narrowing the gap, and

25 said disassembly-facilitating step applies the external force to an inward area of the separator inside the blockage

member in a direction of narrowing the gap, so as to break at least one of the separators.

49. A disassembly method in accordance with claim 38, wherein the breaking guide includes an inclined face that is
5 formed on at least one of the separators and is extended from an outer end position of the sealing member or its nearby position toward an end of the separator to gradually widen the gap between the pair of separators, and

said disassembly-facilitating step applies the external
10 force to an inward area of the separator inside the sealing member in a direction of narrowing the gap between the pair of separators and inserting an edge of a cracking tool along the breaking guide into depth of the gap, so as to break at least one of the separators.

15 50. A disassembly method in accordance with claim 49, wherein said disassembly-facilitating step provides two cracking tools and inserts the two cracking tools from opposite directions into the gap between the pair of separators.

51. A disassembly method in accordance with claim 49,
20 wherein said disassembly-facilitating step inserts the edge of the cracking tool along the breaking guide into the gap between the pair of separators and twists the cracking tool, so as to break at least one of the separators.

52. A disassembly method in accordance with claim 38,
25 wherein the breaking guide includes a thin-wall section formed on at least one of the separators, and

said disassembly-facilitating step applies the external force from outside of said fuel cell to an outer face of the thin-wall section of the breaking guide or a space defined by the thin-wall section.

5 53. A disassembly method in accordance with claim 36, wherein said disassembly-facilitating step inserts a cutting tool from outside of said fuel cell into the gap between the pair of separators, so as to apply the external force.

10 54. A disassembly method in accordance with claim 36, wherein said disassembly-facilitating step cuts the sealing member arranged in the gap between the pair of separators with a cutting tool.

15 55. A disassembly method in accordance with claim 36, wherein said disassembly-facilitating step clamps the pair of separators to apply a pressure and successively shifts a pressing position to give warpage of the separators in directions away from each other.

 56. A disassembly method in accordance with claim 55, wherein the pair of separators are made of a metal.

20 57. A disassembly method in accordance with claim 55, wherein said disassembly-facilitating step heats the sealing member to soften or melt the sealing member, simultaneously with clamping the pair of separators to apply the pressure, and successively shifts a heating and pressing position along a line
25 of the sealing member.

 58. A disassembly method in accordance with claim 55,

wherein said disassembly-facilitating step uses a pair of pressure rollers to clamp the pair of separators for application of the pressure and to successively shift the pressing position.

5 59. A disassembly method in accordance with claim 55, wherein said disassembly-facilitating step uses a pair of rollers with a heater function to heat the sealing member and thereby soften or melt the sealing member, simultaneously with clamping the pair of separators for application of the pressure, and to successively shift a heating and pressing position along
10 a line of the sealing member.

60. A separator, which is used in a pair to be arranged across an electrode assembly having an electrolyte interposed between a pair of electrodes,

said separator comprising a breaking guide that is formed
15 along periphery of said separator for breakage of said separator.

61. A separator in accordance with claim 60, wherein the electrolyte is a solid electrolyte.

20 62. A separator in accordance with claim 60, wherein the breaking guide is used to break said separator at a position outside the electrodes but inside a sealing member, which is arranged along periphery of the electrode assembly.

63. A separator in accordance with claim 60, wherein the breaking guide is formed at or in a neighborhood of a position
25 of a sealing member, which is arranged along periphery of the electrode assembly.

64. A separator in accordance with claim 60, wherein the breaking guide is formed in a thin-wall section of said separator having a less thickness than a thickness of the other part of said separator.

5 65. A separator in accordance with claim 60, wherein the breaking guide is provided on at least one of the separators and is formed on a specific plane of the separator other than a plane facing the electrode assembly.

10 66. A separator in accordance with claim 60, wherein the breaking guide is provided on at least one of the separators and is formed on a specific plane of the separator opposite to a plane facing the electrode assembly.

15 67. A separator in accordance with claim 60, wherein the breaking guide includes a recess continuously formed around periphery of the separator.

68. A separator in accordance with claim 60, wherein the breaking guide includes multiple recesses intermittently arranged around periphery of the separator.

20 69. A separator in accordance with claim 68, wherein each of the multiple recesses has a polygonal opening which has at least one vertex angle of less than 90 degrees.

70. A separator in accordance with claim 67, wherein the recess has any of a wedge-like cross section, a quasi-V-shaped cross section, a quasi-U-shaped cross section, and a
25 quasi-circular cross section in depth of the separator.

71. A separator in accordance with claim 68, wherein the

recess has any of a wedge-like cross section, a quasi-V-shaped cross section, a quasi-U-shaped cross section, and a quasi-circular cross section in depth of the separator.

72. A separator in accordance with claim 67, wherein the
5 recess is also used as a coolant conduit used for cooling down a fuel cell in which said separator is included.

73. A separator in accordance with claim 60, wherein the
breaking guide is mainly made of a different material having
a different physical or chemical property from a physical or
10 chemical property of a material of said separator.

74. A separator in accordance with claim 73, wherein the
breaking guide is formed to make surface of said separator
substantially flat and even.

75. A separator in accordance with claim 73, wherein the
15 breaking guide comprises an element-formed continuously along the periphery of said separator.

76. A separator in accordance with claim 73, wherein the
breaking guide comprises multiple elements formed
intermittently along the periphery of said separator.

20 77. A separator in accordance with claim 76, wherein the
breaking guide has a polygonal exposure area with at least one
vertex angle of less than 90 degrees, on surface of the
separator.

78. A separator in accordance with claim 75, wherein the
25 breaking guide has a wedge-like cross section in depth of the
separator.

79. A separator in accordance with claim 75, wherein the different material has a practically equivalent electrical conductivity to an electrical conductivity of the separator.

80. A separator in accordance with claim 75, wherein the
5 different material has a different hardness from a hardness of the separator.

81. A separator in accordance with claim 80, wherein the different material has a higher hardness than the hardness of the separator.

10 82. A separator in accordance with claim 80, wherein the different material has a lower hardness than the hardness of the separator.

83. A separator in accordance with claim 60, wherein the breaking guide includes an inclined face that is extended from
15 an outer end position of a sealing member, which is arranged along periphery of the electrode assembly, or its nearby position toward an end of said separator.

84. A separator in accordance with claim 83, wherein the inclined face makes a space for insertion of a cracking tool
20 having a sloped edge from the end of said separator toward the sealing member, which is arranged along the periphery of the electrode assembly.

85. A separator in accordance with claim 84, wherein the inclined face has an angle of inclination that is not less than
25 an angle of gradient of the sloped edge of the cracking tool.

86. A separator in accordance with claim 60, wherein the

breaking guide includes a thin-wall section having a less thickness than a thickness of the other part of said separator.

87. A separator in accordance with claim 86, wherein the thin-wall section is formed by cutting down a plane of said
5 separator facing the electrode assembly.